How is the data distributed for the different years?

I want them to experience statistics as a problem-solving process.

Statistics is detective work.

Will exercising make you live longer?

Are hormones good or bad for your heart?

Why aren't people, through time, getting taller?

What are the socioeconomic causes?

Statistics is a process, a vision of learning.

Think about the question "What is statistics?"

And what I'd like to begin with today.

Is just to have you get together in groups and share your different ideas with each other.

...would be a representation of the data?

A group of 17 K-through-8 teachers gathers for a workshop on data analysis, statistics and probability.

And the next one.

We have all the different categories that would go here.

We have "Limiting the Sampling..."

The facilitator

Professor Gary Kader of Appalachian State University begins with the question "What is statistics?"

Let's just pick on the blue group for a minute.

"We gather data.

"Organizing data, analyzing data presenting/explaining..."
What was your thought here?

"Presenting/explaining..."

The data.

KADER:
The data. See?

Drawing conclusions from...?

CLASS:
The data.

KADER:
The data.

In today's session

the key concept to develop

for the teachers is...

is the notion that statistics is

this problem-solving process.

This one, I think, is very interesting.

I'd... I'd like the green group

to elaborate somewhat

on what they're doing there.

That's a very fascinating way

of presenting what's going on

in statistics.

Our little web--

we're all set to turn

that right into

a written report.

Are you?

We're ready.

We broke it down

into two parts:

your plan and design

and then into your

collecting of your data.

Uh-huh, yes, "collecting data"
appears in almost all of them

as does the "organizing data,"
"representing the data"

which I think of, in some vein, as... as organizing data.

"Analysis and..."

"Inferences."

Hmm. What do you mean by that?

What do I mean

by the analy...?

Uh-huh.

You need to take a look

at what your information...
and see if what you are actually collecting is what you are actually looking for.

Uh-huh, okay.

And then finally "conclusions."

Very nice.

Very nice summary of what statistics...

All these are great ideas and they're all related to statistics.

And I think it's better for you to sort of say "Well, these are the things I think go on in statistics" instead of me just getting up here and giving you a list of those things.

We may add some things to this list as we go on but I think this is a real good starting point for what we want to do in this class.

Next, the teachers conduct a statistical investigation.

I'd like you to think about this problem or this question: What piece of information might you be interested in knowing about the other folks in this room? I'd then like you to collect the data.

Clearly, you're going to need data if you're going to do a statistical investigation.

That's kind of the critical element.

A lot of you have mentioned representing the data with graphs and tallies and those sorts of things organizing the data, analyzing the data, presenting the data, okay?

I think statistics is best learned by doing statistics.

It's where you have little... You learn how to do things.
when you do them.

Professor Kader suggests that the teachers begin the investigation by asking a question and then collecting data. He suggests that the teachers ask a question that they can answer with statistics.

Some teachers have been teaching for many years in different school systems. One teacher has been teaching for 35 years in one system. Another teacher has been teaching for 14 years in one system. Some teachers teach in elementary schools, while others teach in high schools. There are also differences in the genders teaching in younger and higher grades.
In grade six.

Next, the teachers graph the data so they can analyze the results.

What we're going to be doing is we're going to be putting our data in order to look at what kind of representation would be the best way to handle this information.

If we use a line plot we're thinking of the scale of the line plot would have to go from...this is the range and it would have to go from zero to 35.

And we could do one increments but not label every one.

Would that be okay?

Mm-hmm.

How much space do you want? Because we've got...

Oh, yeah.

Maybe we can't...let's decide.

We can make the bar...six, two inches each.

Okay.

Let's see, how many bars do you have?

Six, right?

Right.

Let's see.

Let's plan.

Let's see.

Six... six times two is 12 inches...

Twelve.

And then we need to have...let's leave one inch here.

One and one.

KADER: The goal of the activity is to get them active and to get them to thinking about doing statistics in their classroom in this activity-based format.

WOMAN:
If we use one, it's going to be a long range.

We might want to use five... one, five

Instead of... because you're going to have from one to 35.

That's a big, big gap.

Exactly.

So this is going to be "Number of Years"

working outside of education.

Uh-huh, by intervals.

And we're going to have "Number of years."

Mm-hmm.

Let's say "Zero to two."

Mm-hmm, the different years.

"Three to five."

Mm-hmm.

"Six to eight."

Mm-hmm.

KADER: Okay.

I think we've learned some interesting things about this group of people.

I've asked each group to identify one... at least one representative to talk about what it is they've learned about the group.

Come on up.

Well, one of the things that we felt was difficult was coming up with the right question and as you can see, the "Years of teaching experience"

was a question that everybody asked.

And we collected the data in a line plot.

One of the reasons that we decided to show it in a line plot is we thought that it might be more interesting.

that the data might have skewed in different directions

and we found that actually it wasn't as interesting as we thought.
Then we decided to see where the people were teaching--
what grade level were you teaching.
And we found that to best represent that data we made a frequency table.
And we have grade levels one through high school.
What we did discover, though was that you can teach data... statistical analysis
in every grade level, so that this is a good representation.
We do have a representation of every grade except for kindergarten and grade four.
Very good.
( class applauds )
KADER:
Okay, thank you, group three.
All right.
For years of working outside of education
we found that the majority of us went into education within at least two years
after leaving and getting our degrees.
Actually there were eight that were zero--
right... in other words, no years of any other occupation.
And then the rest, from three to five years--
there were three people who had worked for three to five years outside of education.
Two people worked for six to eight years
outside of education.
And then there were three who worked for nine or more years
outside the field of education.
But what we intended to show didn't work out.
If you...
One thing we found that was kind of interesting is
we thought that most of the people who... their undergrad was in some type of education... would probably fall on this chart between the zero and two years. We thought these people would come out of college and know "I want to be a teacher" and go right into education. But that wasn't the case. I think one person had five years' experience in another field, and another person had seven years so we didn't find a very good correlation between the two.

Did't you indicate in your discussion that there was another question that you wish you had addressed? We thought maybe the reason why that is the case is maybe when these people graduated there weren't many jobs out there available. So we thought maybe if we knew people's ages that would help a little bit to help us understand why that was the case. And that often happens that you discover after you've done your investigation that "Gosh, I wish I had asked this," so... I think what we've just seen is really the way statistics works. To use statistics, we have to have data; where we measure some variable. In fact, I think of statistics as having four ingredients.
as a problem-solving process and doing a statistical investigation begins
by taking the problem and asking a statistics question:
"How long have you been teaching?"
"What was your major in undergraduate school?"
"How many years have you been out of education?"
Those sorts of questions, okay.
Once we decide what question we want to ask in statistics we collect appropriate data, if that's at all possible.
We analyze the data, we interpret the results.
One of the things I think that was very interesting that happened in this group is this is not a sequential process always.
A lot of times when we get here we say, "Oh, I want something else" and we start the process all over again.
It's a cyclical process.
It's not necessarily sequential.
You can move from collecting data back to asking the question again.
Often those kinds of things occur.
Next, Professor Kader introduces an activity where the teachers gain additional experience in collecting data.
...because the data is really the heart of what goes on in statistics.
So to really kind of come to an understanding of the kinds of things you do with that data I think you need to experience collecting it.
That makes sense, that's good.
Collecting data gives students a
sense of ownership of that data. It makes the kinds of ways
you look at the data more reasonable.
It gives you more insight, I think, into the whole process.
Now, you're going to be working in pairs and...
NARRATOR: Professor Kader introduces the first problem:
“How many inches wide is the classroom?”
He then asks the teachers to collect three measurements
using three different measuring instruments:
a person's stride, a 12-inch ruler and a tape measure.
Ready?
(The teachers conversing)
KADER: The activity "Measuring the Width of the Room"
 is designed to have the teachers think about how they get data
and to recognize that there are different measuring instruments
that one might use in measuring how wide the room is
and that each measuring instrument has its strengths
and weaknesses.
Nine strides and my stride is exactly 36 inches
so nine times 36 inches and we have our total.
(teacher coughing)
KADER: The goal of the activity is to have the teachers thinking
about the fact that there's variation in data
and that there are lots of sources of variation in data.
Yeah.
But, you know, that's not bad, 15.
(laughs)
Seventy-six.
Plus two more?
Plus...

Eleven and a...

Thirteen and a quarter.

And 289,

that's really off.

292½.

292½.

292½.

So that's not as... as far.

What did you get, Ellen?

292.

If you wanted to know

how wide the room is

you might say, "Well, I think

a pace is about a yard for me.

"I'll step it off in yards

and I can get...

I can get an estimate"--

not necessarily a very good one.

And on the other hand, if I do

happen to have a tape measure

then I can get

a pretty good indication

of how wide the room is.

What do you think?

The class returns to its seats

to compare results

and notices that group six

is the most consistent

in its data collection.

Ahh, their three numbers

are pretty close to each other,

aren't they?

By the criteria

that we've just looked at

all being very consistent,

not to pick on anyone

but which pair was

least consistent?

Okay, we'll admit it, okay?

( laughter )

Okay, which group is this?

Number eight,

and we're proud of it.

Now, why is it that

you say that, group eight?

That we're proud of it?
It's called a defense mechanism.

Let's see, you have a minimum of what?

We had 230 on the first.

230 to 292.

But wait a minute.

Look at number four.

378 to 293.

I'm not sure I want any of you folks building my house any time soon.

Which of these procedures is the best in your opinion?

The tape measure.

The tape measure, exactly.

What's going on with the other procedures?

Number one doesn't have the clear instruction as to where you should start measuring from

when you do the strides.

When you do the strides?

And when you start walking, you know you may actually change that--

that may vary quite a bit.

So certainly that would be the worst one, okay.

Does it look the worst?

The ruler isn't good either because the ruler is only 12 inches, and 12 inches is... There's a lot of variance, so you have to put ruler end to end.

so you're using your finger or something.

and then that might be a couple of inches here and there.

and then you may not get the line straight.

because it can be
broken, you know you have to be really careful.

And it does look like using the tape measure, we did pretty well.

Let's see, we went from 292 to 293 so we only differ by an inch.

But we still have what? Do we all agree?

Okay, so what's the word you said?

Variation.

We made an assumption that the room was square in defense of our 292 where we measured.

Most likely not, but theoretically we made an assumption that the room was square.

Ideally, we would all measure in the same place.

so, in fact, in defense of our 292 it might have been 292 where we measured.

Most likely not, but theoretically we made an assumption that the room was square.

Ideally, we would all measure the same section of the room and even then we may not end up at exactly the same spot, but hopefully there wouldn't be that much variation in our answers.

So that's exactly right. So, what's the lesson?

Why did I do this? You're showing that depending on the tools you use that there are some tools that are much more accurate than others;

obviously the stride is the least accurate of them. That's exactly right.

And the larger tool that you use to have... to measure is going to be
your more accurate one.

411 01:16:03:09 01:16:04:23 KADER: Exactly, but even when using
412 01:16:04:25 01:16:06:28 a more accurate tool, sometimes we still have what?
413 01:16:07:00 01:16:08:16 CLASS: Variation.
414 01:16:08:18 01:16:10:27 Variation, and that variation here is due
415 01:16:10:29 01:16:13:27 to measurement error, okay, for the most part, okay?
416 01:16:13:29 01:16:15:28 It may be due to the lack of the room being square.
417 01:16:16:00 01:16:19:00 But... So part of what you have to deal with
418 01:16:19:02 01:16:21:09 when you collect data in statistics
419 01:16:21:11 01:16:23:29 is variation, and there are all kinds of things
420 01:16:24:01 01:16:25:02 that can contribute
421 01:16:25:04 01:16:27:12 to that variation, okay?
422 01:16:27:14 01:16:29:04 One of them is measurement error.
423 01:16:29:06 01:16:31:25 NARRATOR: Before ending the session, Professor Kader
424 01:16:31:27 01:16:35:11 introduces an activity that focuses on the bias
425 01:16:35:13 01:16:37:15 that sometimes occurs in statistical results.
426 01:16:37:17 01:16:40:15 KADER: Collecting data is a lot of what you do in statistics
427 01:16:40:17 01:16:43:09 and one way we collect data is to take surveys.
428 01:16:43:11 01:16:45:04 I'd like to take a survey
429 01:16:45:06 01:16:48:19 of this group's opinion regarding nuclear power.
430 01:16:51:11 01:16:54:00 KADER: The purpose of the nuclear power survey
431 01:16:54:02 01:16:58:00 was to lead people that you survey to a certain conclusion.
432 01:16:59:17 01:17:02:06 It's called "bias" in your survey.
433 01:17:03:26 01:17:05:10 KADER: I gave some of you
434 01:17:05:12 01:17:07:26 this survey, in which four questions were asked.
435 01:17:27:20 01:17:30:15 Now, not all of you got that questionnaire, did you?
436 01:17:30:17 01:17:33:06 Some of you got this questionnaire.
437 01:17:55:16 01:18:00:10 Now, would you agree, if you said yes to this question
438 01:18:00:12 01:18:03:11 you would more than likely say
WOMAN: No.

Well, let's see what happened. Here are the results from this question that A dealt with:

"Should we reduce the number of nuclear power stations?"

More than half of the people said yes, we should.

In survey B, the last question "Should we maintain our nuclear energy power stations?"

almost everyone said what?

CLASS: Yes.

You were biasing the survey.

That's exactly right.

Some people know what it is they want the world to think and so they go out and design a survey to get them to think that way which is exactly what these two surveys demonstrate.

In fact, I did this survey with a group of students and there are the results I got from that group.

Again, predominately "yes" in both case... cases.

And that's what each survey is leading you to say:

"Yes, yes, yes, yes, I agree with all of these things"

and you sort of get in the flow of saying yes.

Some of you didn't; some of you were clever and saw what I was trying to do.

But if we put the two groups together it's even more apparent.

Again, you would expect people who say yes here would probably say no here, and I don't know--

I mean, I didn't really bias how I gave the survey out--
I just sort of gave A, A, B, B, and so on and so forth.

I'm curious--
you're acknowledging a bias in the survey
and I'm wondering where you identify that bias.

Where I identify it?
Are you saying that because the first three were answered in a particular way it led you to answer the fourth in a particular...
or was it in fact the phrasing of that final question?
Because when I saw it, not knowing the other survey I answered one way but I wanted to qualify it.
I mean, I wrote, "Yes, but..."
I saw your "but."
And I felt the way that it was expressed, the last question itself you didn't even have to have questions one through three biased to the survey.
Oh... okay.
Well, my intent was to have the preceding three questions lead you into that fourth question.
That was my intent so you jumped right into question four of knowing where the survey was going.
I wonder, it would be interesting to see if you kept the first three the same but essentially had the fourth statement
the exact, or maybe just the opposite
so either the answer's yes or no
the wording the same.
I'd be curious in seeing
how that worked out.

I agree.

If you sequence the questions in the right way, you can get people to say just about anything you want them to say.

Yes, Sue?

But if you have a belief before you read that is mostly for people that really are on the fence and don't really have an understanding of the situation?

I agree that for some people, that's not going to sway them, but people who are fence-sitters, "Oh, yes, yes, yes sure, sure, I agree with this," and yes to the last one.

so you're just sort of rolling along there

and that's how, often bias is entered into data that we collect in statistics.

I was also going to say that by the way you word the question, you narrow the choices.

So when you were saying, "Yes, but..."

there's no room for "but."

You eliminate certain responses which is what you might want to do if you are biasing your survey.

Of course, the other side of the coin is that it's difficult to analyze data where you give lots of options.

You can't incorporate every possible option into what you list there.

Unless you break it down.

WOMAN: My question is is there any such thing as a fair survey?

I think
they exist, yeah.

There's a lot of research on that going about asking questions in the right way to not show bias and on the other side of the coin there's probably just as much into phrasing questions to do just what we just demonstrated.

Okay, I want to summarize by saying the model introduced at the end of the first half of the session is something that's going to be with us for the next eight days when you're doing statistics you're really doing four things: you're asking statistics questions; you're collecting data; you're analyzing that data; and you interpret the results in an attempt to provide some sort of answer to this question.

WOMAN: I thought that most of the people that fell in the education... I'm learning that you're not done when you finish the graph.

You should try to answer the question that you first posed.

So I'm learning more process-- not so much the final product of the graph but what's involved in it, and then afterwards looking back and reflecting and analyzing what you've done.

We're also trying to... I feel like I've gained a lot from this statistics class as far as my understanding of it.

I used to teach the skills of statistics but they were in isolation and now I know that they're all connected.
and how to move fluidly through them.

( hammers pounding, power saw whining )

A few years ago I wrote a book called Measure Twice, Cut Once and it's about using the tools in the carpenter's toolbox but it also spends some time talking about measuring.

Every time you measure something with a tool you're subject to inaccuracies either because of the tool itself or because of how you read it or how someone is transferring a measurement to you. All of those things build error into the measurement that you're trying to get.

As carpenters we often work in teams or pairs and you're transferring measurements to one another and you can get a lot of error because you're not using the same measuring tool.

And we can sort of demonstrate that for you. Here we have a folding wood rule.

Tom has a folding wood rule and let's see how close they actually are to one another.

If we butt them up against the same spot on the wall you can clearly see that my rule is longer by almost a sixteenth of an inch here at 39.

So, the tools really do make a difference and every tape will vary one to the other by varying degrees.

But as partners,
you get together

and he would eventually

know that my tape

or my ruler may be

a sixteenth-of-an-inch
difference.

So he would then

compensate for that.

Measuring is somewhat

of a judgment call;

it's all how you read the tape.

For instance, if we're measuring

between this window opening

if I'm standing over here,

I'm saying

that that's reading like 39½.

If I'm standing way over here,

I'm reading, oh, about 39 3/8.

To get the

most accurate measurement

I want to be right dead on

looking straight at it.

in which case

it's between those two

which is 39 7/16, so that's

my most accurate measurement.

Another way that we measure

as builders and carpenters

is actually not to use a tool

at all, but to actually bring

the piece of wood

that we're trying to install.

For instance, if I was trying

to install a piece of wood

between these two walls,

I would bring the piece of wood

put it up

against one side of the wall

and mark the other side.

That way

there's very little error

because the piece that's going
to go there is being marked

rather than taking a measurement

and transferring it.

Every time

you move a measurement

you take the chance

of having an error.

(saw whining)

Now, we are subject

to measuring with tools

and that's really where

"measure twice, cut once"
comes in, is that...

compensate for
those inaccuracies

01:25:35:07 01:25:37:22 take the most accurate measurement that you can take

01:25:37:24 01:25:40:13 so that when you lay out the piece of wood

01:25:40:15 01:25:43:04 that you're going to use and make that cut

01:25:43:06 01:25:44:14 it's going to fit.

[Captioned by The Caption Center WGBH Educational Foundation]